IMPACT OF PROGRAMMING WORKSHOP ON IMPRESSION REGARDING COMPUTER PROGRAMMING

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ABSTRACT

To investigate the effects previous experience on the impressions of parents regarding computer programming, a survey was carried out before and after parent−children workshops were conducted. The results of the survey showed that the impressions of the participants regarding computer programming after the workshops became more positive than before the workshops.

KEYWORDS

Computer Programming, Elementary School, Parent Impression, Semantic Differential Method, Programming Workshop

1. INTRODUCTION

There have been widespread attempts to introduce computational thinking into K–12 education (Barr 2011, Grover 2013). The term "computational thinking" was first used by Papert (1993) and was popularized by Wing (2006). According to Wing, "computational thinking involves solving problems, designing systems, and understanding human behavior, by drawing on concepts that are fundamental to computer science" (p. 33). In addition, the author stated that computational thinking is a fundamental skill and should be added to every child's analytical ability. The article caught the attention of many educational researchers and educators, and many research studies related to computational thinking in K–12 education have since been carried out. In the United Kingdom, a new subject, "computing," was introduced to primary and secondary schools. In the primary teachers' guide for this subject, the importance of computational thinking is repeatedly stated.

As computational thinking continues to receive an increasing amount of attention, programming education is also receiving attention as one of the ways for teaching computational thinking. Lye and Koh (2014) stated that "programming is more than just coding; for, it exposes students to computational thinking which involves problem-solving using computer science concepts, and is useful in their daily lives" (p. 51). In Japan, the central council for education in the Ministry of Education, Culture, Sports, Science, and Technology submitted a report mentioning the introduction of programming education to elementary schools. Another council report stated that programming education in elementary schools should not aim to teach students how to code, but rather to foster programming thinking (translated by the author). Programming thinking is considered to be a concept similar to computational thinking and is considered to be a part of computational thinking. However, the idea of programming education has not adequately infiltrated the public. Misconceptions and anxieties concerning programming education seem to have spread among parents. Parents play a significantly important role in elementary education, and their attitudes toward education have a considerable influence on their children's attitudes. Indeed, some researchers have investigated parent−child collaboration in robotics education (Cuellar et al. 2013, Roque et al. 2016) and in learning programming (Lin and Liu 2012, Hart 2010). These studies showed that the experiences of parent–child collaboration affect the parents' attitudes toward such education. Maruyama (2019) suggested that experiences in programming workshops for parents and children improved the parents' attitudes toward, and their confidence in, supporting their children in learning computer programming. Moreover, it is conceivable that experiences at programming workshops will have an effect on changing the parents' impression of programming itself.

This paper provides the results of a preliminary investigation into the influence of participation in a programming workshop for children and parents on changes in parent impressions of computer programming.

2. RELATED STUDIES

2.1 Research Studies on Parents' Role in Education Involving New Technologies

As mentioned above, the attitudes of parents toward education have a considerable influence on the attitudes of their children.

Hart (2010) carried out a computer science-based workshop that targeted fourth through sixth graders, mainly female students, and their parents. The participants took part in an attitudinal survey during the first and last sessions of the workshop. The results of this survey show their perceptions regarding general computer use and their potential for developing a career as a computer scientist and that the perceived differences in ability based on gender became positive during the last session. Moreover, much of the feedback from parents was positive.

Lin and Liu (2012) observed three parent−child pairs at a computer camp where they used MSWLogo. They found that parent−child collaboration during programming naturally fell into a special form of "pair programming" and that children wrote programs in a more systematic and disciplined manner. Moreover, they reported that the programs produced by these participants were relatively more compact, well-structured, and error-free.

Cuellar et al. (2013) conducted a robotics education workshop in which parents and children interacted by experimenting with the concepts of robotics and by developing problem solving skills. They expected the students to become more interested in technology and their parents to encourage them to pursue engineering and science majors. As a result, they observed enhanced teamwork and interaction as well as a positive attitude toward the initiative over the course of the workshop.

Thus, parent involvement in education significantly impacts the attitudes and outcomes of the children. However, it seems that some parents have low confidence in their involvement in education, particularly regarding new technology.

Feng et al. (2011) regard parents as important influencers in their children's decision to attend a robotics course and the use of educational robots among children. Therefore, they investigated the parent perception of edutainment products, including programmable bricks. They sent questionnaires to 55 parents and received 26 valid responses. The questionnaires included questions about the usefulness of programmable bricks and the respondent's confidence in teaching using such devices. The results showed that parents considered programmable bricks to be useful for their children; however, they were not confident in using them to teach their children. Taking this into account, Feng et al. alluded to future research into customized courses for both parents and children as a means of improving the confidence of parents in teaching their children.

Lin et al. (2012) investigated parent perceptions regarding educational robots. The results of the responses to self-reported questionnaires from 29 parents indicated that the parents had a positive attitude toward educational robots and considered learning about such robots to be beneficial for their children. In addition, they found that parents had little confidence in using educational robots to teach or play with their children. Therefore, they suggested that it was crucial to train or teach the parents about such robots.

As mentioned in these two research studies, participation in educational workshops can be a promising method for improving parent attitudes and confidence.

Maruyama (2019a) examined the impact of different types of workshop activities on parent concerns regarding their children's programming education. Three types of workshops were organized, each characterized by a particular activity, including a wooden robot with coding blocks, a robotics toy with visual programming language, and visual language. Data were collected from the parents before and after their participation in these workshops. The results from the data analysis revealed that the impact of the three activities on the parents varied, with all three activities and workshops having a positive impact on the

attitudes and confidence levels of the parents in supporting their children at home with technology-related education in addition to enhancing their understanding of programming education.

As described above, participation in workshops with their children is likely to improve the attitudes of parents and provide them with confidence regarding programming education. However, the effect on parent impression of the learning material itself has yet to be investigated in depth. The impressions of the learning materials are considered to influence the attitude of parents toward supporting their children. By investigating changes in impressions, we can gain insights on how to encourage parents in this area.

2.2 Research Studies on Impression toward Computer Programming

Ando et al. (2017) conducted surveys to investigate the impressions of teachers and students regarding computer programming based on a semantic differential (SD) method (Osgood 1952). The subjects of these surveys included 146 elementary school teachers, 242 university students, and 35 elementary school students.

Overall, the results showed the following trends:

1) The subjects believe that computer programming is modern and cool.

2) The subjects feel highly motivated to acquire computer programming skills and believe that it is necessary to acquire such skills.

3) The subjects feel that computer programming is difficult.

4) The subjects are aware that they are not good at computer programming.

Maruyama (2019b) conducted a survey before and after parent–child workshops to investigate the effects of computer programming experience on parent impressions of computer programming. The respondents to this study appeared to be relatively familiar with computers but were not very skilled. The results of the survey showed that their impressions regarding computer programming after the workshops were more positive than they were before the workshops. However, the number of participants in this survey was limited, and it was suggested that a survey with more participants and a detailed analysis of the results be conducted.

This paper reports the results of a further investigation into the impressions of parents toward computer programming. The details of the changes in impression of computer programming before and after the workshop are examined.

3. METHOD

The survey used for this study was carried out in programming workshops conducted for children and their parents, which were organized by the author.

3.1 Programming Workshops

The programming workshops took place in August 2018 and in March and August 2019. The participants were recruited through brochures distributed at 19 local elementary schools in Kanagawa, near Tokyo. The children were required to attend the workshops with their parents or guardians. Three types of workshops were held 42 times each in total over a period of 21 days. Each parent–child pair took part in one workshop. Each workshop lasted for 2 h with a break in the middle. Each workshop was moderated by an instructor (author) and an assistant (university student). At the beginning of each workshop, a short lecture on computer programming was presented. After a short lecture, the workshop activities were conducted.

In workshop 1, a Cubetto (Primo Toys, https://www.primotoys.com/) was used. Cubetto is an educational and screenless coding toy for children aged 3–6. Users can make a program that controls Cubetto’s movements using coding blocks by placing them on a control board. The workshop targeted first and second grade students. During the workshop, each group used one Cubetto set.

In workshop 2, a toy robot, i.e., a BB-8™ App-Enabled Droid™ (Sphero, https://www.sphero.com/), and the visual programming language SpheroEdu (https://edu.sphero.com/) were used. The workshop targeted third–sixth grade students. During the workshop, each group used one BB-8.

In workshop 3, the visual programming language Scratch (The Lifelong Kindergarten Group at the MIT Media Lab, https://scratch.mit.edu/) was used. The workshop targeted first through sixth grade students. In the workshop, parents and children used a computer on their own.

A total of 398 groups (83 in August 2018, 149 in March 2019, and 166 in Aug 2019) took part in the workshop.

3.2 Investigation

The survey was carried out using questionnaires. The participants of the workshops were handed two questionnaires at reception and were asked to voluntarily fill them out before and after the workshops. A total of 293 valid responses were obtained. Among the 293 respondents to the survey, 176 were mothers, 112 were fathers, and 2 were grandfathers of elementary school children. The average age of the respondents was 42.4.

The questionnaires had the following sections: 1) demographics of the participants and their children (only for the questionnaire administered before the workshop), 2) the impression of the participants toward computer programming, 3) the interest of the participants in programming education, 4) attitudes of the participant toward programming education in elementary schools, 5) the expectations from introducing programming education to elementary schools, 6) anxieties regarding the introduction of programming education, 7) attitudes toward and confidence in supporting children's programming education at home, and 8) the computer experience of the participants (only in the questionnaire administered before the workshop). There were other questions that sought responses from the children.

This paper focuses on section 2. In this study, the SD method was used. The measurement items in section 2 were based on a study by Ando et al. (2017). Nineteen pairs of Japanese adjectives, the meanings of which are listed in Table 1, were used. Originally, each item was a one-word Japanese adjective; however, in Table 1, some items were translated into multiple English words such that their meanings were as close as possible to the original Japanese. For each pair of words, the word on the left side has a positive connotation, whereas the word on the right side has a negative connotation, with a few exceptions. The participants were asked to evaluate on a 5-point scale which of the two words in each pair was closer to their impression of the computer programming workshop. The answers were converted into values of 1–5, where a value of 1 is closest to the left-side word in each pair and 5 is closest to the right-side word. That is, small values indicate a relatively positive impression.

Table 1. Measurement items for impression of computer programming

No.	Item meanings	No.	Item meanings
1	New - Old	11	Enjoyable - Dull
2	Cool - Not cool	12	Cheerful - Gloomy
3	Necessary - Unnecessary	13	Quick - Slow
4	Want to acquire - Do not want to acquire	14	Stand out – Does not stand out
5	Want to try – Do not want to try	15	Want to use – Do not want to use
6	Like a play - Like a study	16	Soft - Solid
7	Good at - Bad at	17	Easy to understand - Difficult to understand
8	Easy - Difficult	18	Adult-like - Child-like
9	Fun - Hard	19	Amazing - Average
10	Like - Dislike		

4. RESULTS AND DISCUSSION

Figure 1 shows the average values of each item for all respondents, the respondents in workshop 1, the respondents in workshop 2, and the respondents in workshop 3. In each figure, the solid lines represent the values before the workshops, whereas the dashed lines represent the values after the workshops. For the results of all respondents, after the workshops, the average values decreased compared with before the workshops except for item 3 (Necessary – Unnecessary), item 13 (Quick – Slow), and item 18 (Adult-like – Child-like). As mentioned above, small values indicate a positive impression; thus, the general impressions of the respondents toward computer programing after the workshop were more positive than those before the workshop. The results of a Wilcoxon signed-rank test (Table 2) indicate statistically

significant differences before and after ($p < 0.05$) the workshops for all items except items 4 and 13. With regard to item 4 (Want to acquire – Do not want to acquire), the average value was 1.69, which was originally high. This suggests that participation in a programing workshop had a positive impact on the impression of parents toward computer programming. This result is consistent with the author's previous research (Maruyama 2019b). Furthermore, similar tendencies can be seen in the graphs of each workshop. However, compared with the results of all respondents, the number of items with a statistically significant difference was slightly smaller.

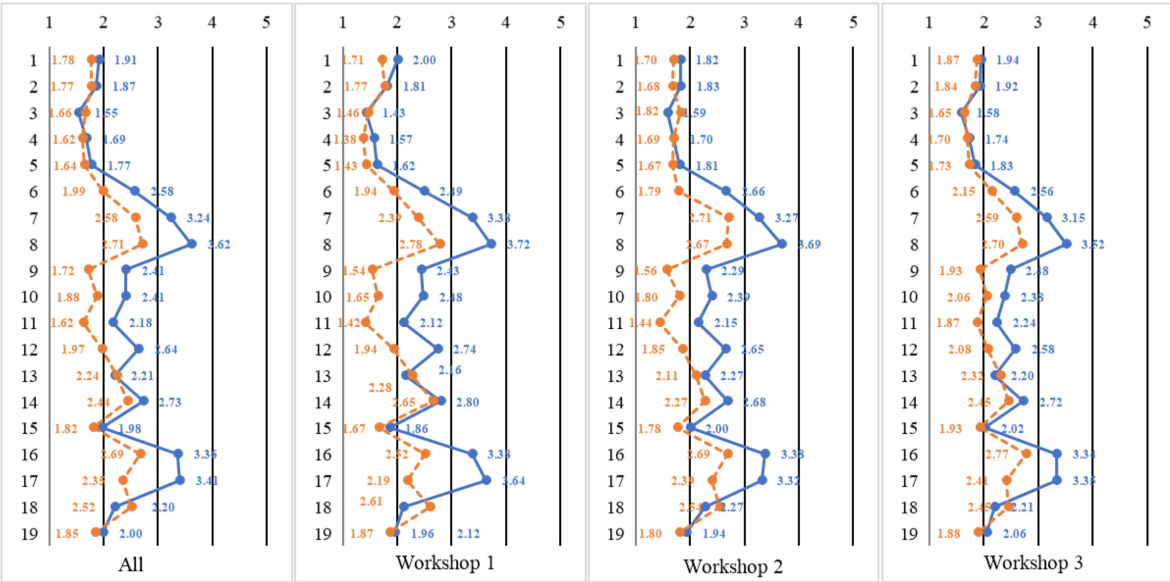

Figure 1. Average values of each item for impression

Table 2. Measurement items for impression of computer programming

	1	2	3	4	5	6	7	8	9	10
All	0.005	0.018	0.013	0.104	0.004	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Workshop 1	0.005	0.559	0.833	0.026	0.035	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Workshop 2	0.152	0.036	0.016	0.881	0.136	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Workshop 3	0.391	0.191	0.285	0.472	0.122	0.001	< 0.001	< 0.001	< 0.001	< 0.001

	11	12	13	14	15	16	17	18	19
All	< 0.001	< 0.001	0.708	< 0.001	0.003	< 0.001	< 0.001	< 0.001	0.004
Workshop 1	< 0.001	< 0.001	0.345	0.281	0.047	< 0.001	< 0.001	0.001	0.370
Workshop 2	< 0.001	< 0.001	0.118	< 0.001	0.025	< 0.001	< 0.001	0.003	0.126

$p < 0.05$

A factor analysis was conducted on the impressions before and after the workshops for all respondents. In addition, a factor analysis was applied on the impressions after the workshop for the respondents in each workshop. To determine the number of factors and eliminate inappropriate items, three preliminary analyses were applied to all datasets. From the results of the preliminary analyses, the number of factors was determined to be three. In addition, items 6 and 18 were eliminated from further analysis because their factor loadings were smaller than 0.35. Finally, all datasets were analyzed through a factor analysis using a Promax rotation. Table 3 shows the factor loadings matrixes before and after the workshops for all respondents.

With regard to the results before the workshops, items 7, 8, 9, 10, 11, 16, and 17 were extracted as the first factor. All items except item 16 were considered as words regarding feelings produced from the experience. Because these are the answers before going through the workshop, it is probable that the respondents answered in anticipation of how they felt. Three of the items, Easy – Difficult, Good at – Bad at, and Easy to understand – Difficult to understand, are considered as feelings related to the difficulty of computer programming. Three other items, i.e., Like – Dislike, Enjoyable – Dull, and Fun – Hard are

considered feelings of enjoyment. The factor loadings for Easy – Difficult and Good at – Bad at were 0.800 and .0723, respectively, which were high. This suggests that difficulty was more relevant to the feelings of the participants than enjoyment. The average values of items related to difficulty were all over 3, which implies that the participants seemed to expect that programming was difficult before the workshops. It is conceivable that participants were worried regarding whether they could program well and, thus, they were not sure if they were able to enjoy it. Their impression seemed to depend on the difficulty rather than their enjoyment. The factor loading of item 16, which was Soft – Solid, was 0.406, which is not too high.

As the second factor, four items, i.e., Want to acquire – Do not want to acquire, Want to try – Do not want to try, Want to use – Do not want to use, and Necessary – Unnecessary, were extracted. These items are considered as expressing the motivation for computer programming and appear to reflect the interest and importance of participants in computer programming. The average values of these items are all under 2. This suggests that the participants have a high motivation for trying to learn how to program. In particular, the value for item 3 (Necessary – Unnecessary) was 1.55, which indicates that participants strongly felt its importance, and might be an importance-led motivation. Six items, i.e., Cool – Not cool, New – Old, Stand out – Does not stand out, Amazing – Average, Cheerful – Gloomy, and Quick – Slow, were extracted as the third factor. The items in the first and second factors are feelings obtained from performing an activity, and the items in the third factor are not necessarily feelings based on performance.

However, the factor structure changed after the workshops were conducted. Seven items were extracted as the first factor. Three were included in the first factor before the workshops, which were related to a feeling of enjoyment. The other four items were consisted the second factor before the workshops, and were items related to motivation. The second factor consisted of the same items as in the third factor before the workshops. The third factor consisted of four items from first factor before the workshops. Three of them are related to the level of difficulty.

Before the workshop, items related to difficulty and items related to enjoyment were included within the same factor; however, after the workshop they were included within different factors. It seems that the difficulty came to have less influence on the enjoyment of the participants. After the workshops, the average values of the items related to difficulty became smaller than before, which suggests a decrease in the idea of the participants that programming is difficult. Therefore, it seems that the participants came to become less concerned about programming difficulties. However, items related to enjoyment were included in the same factor as items related to motivation. The experience of fun at the workshop may have helped further motivate them.

Table 3. Factor loading matrixes before and after workshops for all respondents

Before workshop	1	2	3	After workshop	1	2	3
Easy – Difficult	.800	−.155	−.222	Want to acquire – Not want to acquire	.947	−.038	−.116
Good at – Bad at	.723	.093	−.346	Want to try – Not want to try	.901	.007	−.124
Like – Dislike	.660	.294	.077	Want to use – Not want to use	.725	.055	.047
Fun – Hard	.637	.116	.302	Necessary – Unnecessary	.645	.117	−.142
Easy to understand – Difficult to understand	.626	−.116	.089	Like – Dislike	.632	−.073	.343
Enjoyable – Dull	.574	.220	.181	Enjoyable – Dull	.553	.101	.270
Soft – Solid	.406	.058	−.103	Fun – Hard	.476	.090	.373
Want to acquire – Not want to acquire	−.070	.932	−.078	Cool – Not cool	.100	.868	−.177
Want to try – Not want to try	.057	.803	−.035	New – Old	.039	.759	−.170
Want to use – Not want to use	.186	.631	.097	Amazing – Average	.084	.718	−.070
Necessary – Unnecessary	−.043	.621	−.025	Cheerful – Gloomy	.023	.566	.283
Cool – Not cool	−.206	.220	.631	Stand out – Not stand out	−.087	.535	.238
New – Old	−.266	−.015	.606	Quick – Slow	−.104	.448	.401
Stand out – Not stand out	.181	−.119	.600	Easy – Difficult	−.185	−.079	.918
Amazing – Average	−.338	.087	.589	Easy to understand – Difficult to understand	−.040	.159	.693
Cheerful – Gloomy	.496	−.261	.562	Good at – Bad at	.189	−.318	.641
Quick − Slow	.130	−.031	.381	Soft – Solid	−.020	.100	.490

Similar factor structures were obtained from the analysis after each workshop. With regard to workshop 2, the factor structure was the same as the factor structure of all respondents. With regard to workshop 3, although items included in each factor were the same as the result for all respondents, the factor order changed. Items related to difficulty were extracted as the first factor, items related to motivation and enjoyment were extracted as the second factor, and other items were extracted as the third factor. With regard to workshop 1, only two items, i.e., Easy – Difficult and Good at – Bad at, were extracted as the third factor. It is necessary to further examine whether the difference in the teaching materials has an effect.

Table 4. Factors after each workshop

Workshop 1	Workshop 2	Workshop 3
Want to acquire − Not want to acquire	Want to acquire − Not want to acquire	Easy − Difficult
Want to try − Not want to try	Want to try − Not want to try	Good at − Bad at
Like − Dislike	Want to use − Not want to use	Easy to understand – Difficult to understand
Want to use − Not want to use	Like − Dislike	Soft − Solid
Enjoyable − Dull	Necessary − Unnecessary	Want to try − Not want to try
Fun − Hard	Enjoyable − Dull	Want to acquire − Not want to acquire
Necessary − Unnecessary	Fun − Hard	Necessary − Unnecessary
New − Old	Cool − Not cool	Want to use − Not want to use
Cool − Not cool	New − Old	Enjoyable − Dull
Amazing − Average	Amazing − Average	Like − Dislike
Easy to understand − Difficult to understand	Cheerful − Gloomy	Fun − Hard
Cheerful − Gloomy	Stand out − Not stand out	Cool − Not cool
Stand out − Not stand out	Quick − Slow	Amazing − Average
Soft − Solid	Easy to understand − Difficult to understand	New − Old
Quick − Slow	Easy − Difficult	Stand out − Not stand out
Easy − Difficult	Soft − Solid	Cheerful − Gloomy
Good at − Bad at	Good at − Bad at	Quick − Slow

5. CONCLUSION

To investigate the effects of experience with computer programming on the impressions of parents of elementary school children, a survey was carried out before and after parent−children computer programming workshops were conducted.

The results of the survey showed that the impressions of the participants regarding computer programming after the workshops became more positive than they were before the workshops. Before the workshops, the impressions of the participants seemed to depend on difficulty rather than enjoyment. After the workshops, the participants seemed to become less concerned with programming difficulties. Moreover, the experience of fun at the workshop may had helped further their motivation.

However, the effects of the different activities of the workshop could not be confirmed, and it will be necessary to examine this further. Furthermore, an investigation into how the changes in the impressions of the parents affected their children should be conducted.

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